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Impact of smoking and preoperative electrophysiology on outcome after open carpal tunnel release

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1 **Impact of smoking and preoperative electrophysiology on**
2 **outcome after open carpal tunnel release**

3

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17

18 **Abstract**

19 **Background:** Our aim was to evaluate the influence of smoking and preoperative
20 electrophysiology on the outcome of open carpal tunnel release.

21 **Methods:** This retrospective observational study evaluated the outcome in 493 patients (531
22 hands) primary operated for carpal tunnel syndrome. Data were collected from medical
23 records, health evaluations and QuickDASH questionnaires before surgery and one year after.

24 **Results:** Smokers had a higher QuickDASH score preoperatively as well as postoperatively,
25 but the change in total score did not differ. The odds of having a postoperative QuickDASH
26 score >10 were 2.5 higher in smoking patients than in non-smoking patients. In 124/493
27 patients (25%), no clinically significant improvement was seen. Normal and extreme
28 preoperative electrophysiology values were associated with higher postoperative scores. No
29 correlation was found between preoperative QuickDASH scores and preoperative
30 electrophysiology values.

31 **Conclusions:** Smokers with carpal tunnel syndrome experience more symptoms
32 preoperatively. Smokers have remaining symptoms after surgery. There is no correlation
33 between preoperative QuickDASH scores and preoperative electrophysiology values. Patients
34 with normal or near to normal preoperative electrophysiology results have limited
35 improvement after surgery.

36

37 **Key words:** carpal tunnel syndrome, carpal tunnel release, smoking, electrophysiology

38 **Introduction**

39 The most common nerve compression in the upper extremity is carpal tunnel syndrome
40 (CTS), particularly frequent among women and patients >55 years of age (Atroshi et al.,
41 1999). Risk factors for development of CTS include overweight (Lam and Thurston, 1998),
42 diabetes (Hou et al., 2016) and exposure to hand held vibrating tools (Tseng et al., 2012).
43 There are conflicting results concerning smoking as a risk factor for developing CTS
44 (Geoghegan et al., 2004, Maghsoudipour et al., 2008, Nathan et al., 2002), and it has been
45 reported that symptom resolution is less frequent in current smokers following surgical
46 release (Coggon et al., 2013).

47

48 Treatment strategies in patients with CTS depend on severity of symptoms, where mild
49 symptoms can be treated with splinting and self-care instructions, whereas for moderate to
50 severe symptoms surgical treatment is recommended. When diagnosing CTS and choosing
51 patients suitable for surgical treatment, nerve conduction studies are often used to assist in the
52 decision-making. It has been implied that patients with normal and near-normal
53 electrophysiology values, as well as those with extremely pathological electrophysiology
54 values, may benefit less from surgical treatment (Bland, 2001). However, no correlations
55 seem to exist between nerve conduction, symptom severity and outcome of surgery in patients
56 with CTS (Longstaff et al., 2001).

57

58 The standard surgical procedure at our hospital is open carpal tunnel release (OCTR). It is
59 generally known to have a favorable outcome (Scholten et al., 2007). However, in some
60 patients the outcome is not satisfactory in spite of an adequate surgical procedure.

61

62 We aimed to evaluate outcome of OCTR, using the QuickDASH (Disability of Arm, Shoulder
63 and Hand) questionnaire (Zimmerman et al., 2016) (Dahlin et al., 2016), with focus on the
64 influence of smoking and preoperative electrophysiological findings. In addition, we assessed
65 the characteristics of the patients who did not improve following the surgery.

66

67 **Materials and Methods**

68 We conducted a retrospective observational study on patients who underwent OCTR at our
69 hospital from September 2009 to February 2011. Patients were identified through the hospital
70 administrative register by the operation code ACC51. QuickDASH questionnaires are
71 routinely sent out to all patients planned for surgery at our department. Patients who had
72 completed a valid questionnaire preoperatively and one year after surgery were included.
73 Patients who were re-operated during the study period because of persistent or recurrent
74 symptoms were excluded, since our aim was to investigate the outcome of primary releases,
75 and re-operations come into a completely different category that could include recurrence,
76 inaccurate diagnosis and inaccurate treatment.

77

78 QuickDASH total score ranges from 0-100 (the higher the score, the more disability)
79 (Zimmerman et al., 2016). The Swedish version of QuickDASH was used (Gummesson et al.,
80 2003). An eight point change from QuickDASH score preoperative to postoperative follow-up
81 has been suggested as the minimal clinically important difference (Mintken et al., 2009) and a
82 postoperative total score of more than ten is considered to represent persistent disability
83 (Hunsaker et al., 2002).

84

85 Data were collected from medical records and from a declaration of health that patients
86 completed preoperatively. Preoperative electrophysiology findings were classified as

87 described by Padua (Padua et al., 1997), using sensory conduction velocity in the median
88 nerve over the wrist (SCV). The electrophysiology findings were classified accordingly as
89 negative (normal findings), minimal (solely abnormal segmental and/or comparative studies),
90 mild (abnormal digit = wrist conduction and normal median distal motor latency), moderate
91 (abnormal digit = wrist conduction and abnormal median distal motor latency), severe
92 (absence of sensory response and abnormal median distal motor latency) or extreme (absence
93 of thenar motor responses). For the sake of simplicity, we present the patients classified as
94 negative and minimal ad modum Padua together as normal. A consultant in clinical
95 neurophysiology evaluated all measurements. We also used sensory nerve action potential
96 amplitude (SNAP) in the median nerve recorded from the long finger as a measurement of the
97 number of functioning nerve fibers. SNAP is a recording of the number of excitable sensory
98 axons – a higher SNAP indicates better sensory functioning (Robinson, 2015).

99

100 Continuous data are presented as median [interquartile range, IQR]. Mann-Whitney U-test
101 was used for comparing continuous data. Nominal data presented as number (%) and
102 evaluated by chi-square test. Kruskal Wallis test was used to calculate significance of
103 differences if more than two groups were compared, with a subsequent Mann-Whitney U-test.
104 Spearman's correlation was used to correlate neurophysiological values and preoperative
105 QuickDASH total score. A binary logistic regression was used to calculate odds ratio (OR). A
106 p-value < 0.05 was considered statistically significant.

107

108 **Ethics**

109 The study protocol was presented to the regional Ethics Committee (#2011/607). They found
110 the study sound, without ethical problems and judged that the study was not applicable in the
111 Swedish Ethical Review Act. Neither advertising nor formal informed consent by each patient

112 was needed. Chief of service at our department approved the quality control. Therefore, no
113 formal permission number has been attached to the study.

114

115 **Results**

116 493/962 patients were included in the study (Zimmerman et al., 2016). Thirty-eight patients
117 were operated bilaterally during this period; they completed two separate QuickDASH
118 questionnaires (one per hand) and are included as one operation with mean QuickDASH
119 scores.

120

121 Excluded patients, i.e. not completing both pre- and postoperative questionnaires or having a
122 reoperation, were younger (median 47 [IQR 38-56] years) than the included patients (55 [46-
123 66]; $p<0.0001$), but did not differ with respect to gender [data already published,
124 (Zimmerman et al., 2016)]. The effect of diabetic status, obesity, hypertension,
125 polyneuropathy and statin treatment on surgical outcome is also addressed in another
126 manuscript from the same study population (Zimmerman et al., 2016).

127

128 The number of smoking patients in the population was 94/493 (19%) (missing data about
129 smoking status in seven patients). Patients who smoked were younger and their preoperative
130 median nerve sensory conduction velocity at wrist level was higher than the non-smoking
131 patients (Table I). Smoking patients had higher SNAP in the middle finger than non-smoking
132 patients ($p=0.003$; Table I). They had a higher QuickDASH total score both preoperatively
133 ($p<0.0001$; Table II) and postoperatively ($p<0.0001$; Table II) compared to non-smoking
134 patients, but there was no difference in the change in total score. However, a higher number
135 of smoking patients had a postoperative total score >10 ($p<0.002$; Table II) and fewer of the
136 smoking patients had a change >8 and postoperative score <10 ($p<0.008$; Table II). The odds

137 indicating persistent symptoms, i.e. postoperative QuickDASH score >10, were higher in
138 smoking patients than in non-smoking patients (Table III).
139 When analyzing separate questions in the QuickDASH, smoking patients scored higher on
140 item ten “severity of tingling (pins and needles) in your arm, shoulder or hand in the last
141 week” than non-smoking patients postoperatively (median 2.0 IQR 2 vs. median 1.5 IQR 2,
142 $p<0.05$). Smoking patients also scored higher on item nine “severity of arm, shoulder or hand
143 pain in the last week” both preoperatively (median 4.0 IQR 1 vs. median 3.0 IQR 2,
144 $p<0.0001$) as well as postoperatively (median 3.0 IQR 2 vs. median 2.0 IQR 2, $p<0.0001$).
145 Smoking patients rated item 11 “during the past week, how much difficulty have you had
146 sleeping because of pain in your arm, shoulder or hand?” higher than non-smoking patients
147 preoperatively (median 4.0 IQR 1 vs. median 3.0 IQR 2, $p<0.0001$) and postoperatively
148 (median 2.0 IQR 2 vs. median 1.0 IQR 1, $p<0.0001$).

149
150 In 124/493 (25%) patients, there was a change in QuickDASH total score <8 . In this group,
151 there were more patients diagnosed with polyneuropathy (diagnosis found in medical records
152 or in preoperative neurophysiological statement) ($p=0.01$; Table I). Patients with a change <8
153 had higher sensory conduction velocity in the median nerve at wrist level than patients with a
154 change >8 ($p=0.02$; Table I). Patients with a change <8 also had higher SNAP in the middle
155 finger than patients with a change >8 in the QuickDASH ($p<0.05$; Table I). The patients with
156 less improvement (i.e. change <8) also had higher postoperative QuickDASH total score
157 ($p<0.0001$; Table II) and there were more patients in this group with a postoperative total
158 score of >10 ($p<0.0001$; Table II).

159
160 Of the 299 patients that had undergone preoperative electrophysiology testing, 26 (8%) were
161 classified as normal (i.e. negative and minimal), 30 (11%) as mild, 123 (43%) as moderate, 63

162 (23%) as severe and 43 (15%) as extreme. Seventeen patients could not be assessed due to
163 missing data or severe polyneuropathy and they were therefore excluded in the evaluation.
164

165 There was no difference in the preoperative QuickDASH score between any of the
166 electrophysiology groups ($p=0.73$), or in the change in total score ($p=0.11$). However, the
167 postoperative QuickDASH scores differed between the electrophysiology groups ($p=0.046$),
168 where patients classified as having normal values as well as the patients with extreme CTS
169 had higher QuickDASH scores postoperatively than those graded as severe (both $p=0.02$;
170 Figure 1). There were differences in the number of patients with a postoperative change in
171 QuickDASH score <8 with respect to electrophysiological classification (chi-square $p=0.025$)
172 (Figure 2). When comparing the adjacent groups, we found that the group classified as mild
173 had higher postoperative scores than the group classified as moderate ($p=0.04$).

174 The distribution of age varied between the different groups (Kruskal-Wallis $p<0.0001$).

175 Patients classified as extreme were oldest (median 71 IQR 25 years), whereas the patients
176 classified as normal were youngest (median 48 IQR 18 years). The other groups' age
177 distribution was as follows: mild: median 60 IQR 18 years, moderate: median 53 IQR 16
178 years and severe group: median 63 IQR 23 years. Significance was found between normal and
179 severe ($p=0.001$), normal and extreme ($p<0.0001$), moderate and severe ($p=0.001$), moderate
180 and extreme ($p<0.0001$).

181 Twenty-six patients had normal electrophysiology values, and only 15 of these had a
182 clinically significant improvement (i.e. QuickDASH change >8). Twenty-one of the 26
183 patients (81%) with normal electrophysiology values had a postoperative total score of >10 .
184 In the logistic regression, neither the preoperative sensory conduction velocity (SCV) in the
185 median nerve over the wrist nor the SNAP in the middle finger affected the odds of having a

186 postoperative score >10 (Table III). SNAP slightly increased the OR on total score change <8
187 in the univariate analysis and in the first model (Table III).

188 There was no correlation between the preoperative total scores and the preoperative sensory
189 conduction velocity in the median nerve at wrist level (Figure 3). No correlation was found
190 between preoperative total scores and SNAP in the middle finger (Spearman's $r = -0.003$,
191 $n=312$, p -value >0.05).

192

193 **Discussion**

194 Current tobacco smoking in patients with CTS increased the severity of the preoperative
195 symptoms and was associated with persistent symptoms following OCTR. Smokers improved
196 their QuickDASH scores to the same extent as non-smokers after OCTR, but they
197 experienced more symptoms since a) they had higher postoperative QuickDASH scores, b)
198 more smokers had a total score of >10 postoperatively c) less smokers had a change >8 and a
199 postoperative score <10 and d) smoking increased the odds of having a postoperative score
200 >10. A few studies have pointed towards smoking as a risk factor for developing CTS
201 (Geoghegan et al., 2004, Maghsoudipour et al., 2008, Nathan et al., 2002), and smoking is
202 associated with more persistent symptoms after surgery for CTS (Coggon et al., 2013). We
203 show that smoking patients may benefit from surgery to the same extent as non-smokers, but
204 smoking seems to be associated with worse symptoms before surgery as well as more
205 persistent symptoms after surgery. The pathophysiological mechanism behind smoking as a
206 risk factor for CTS is not known, but it could be related to a decreased intraneural blood flow
207 leading to hypoxia since microvascular factors are crucial for development of CTS (Rempel et
208 al., 1999). The smokers may have less structural alterations in the compressed median nerve,
209 since they had a better nerve function preoperatively, as indicated by a higher sensory
210 conduction velocity at wrist level and higher SNAP compared to non-smokers.

211 In addition, smoking may alter pain sensation (Carstens et al., 2001, Nakajima and al'Absi,
212 2011), which may be one contributing reason to why the smoking patients with CTS reported
213 more symptoms both pre- and postoperatively than the non-smoking patients. There was also
214 a difference in the pain-related items in QuickDASH (pain, tingling and difficulty sleeping
215 due to pain), where the smokers rated themselves higher on all these items than non-smokers,
216 both before and after surgery. This might indicate that there is a difference in how pain from
217 CTS is perceived dependent on smoking status. It is possible that smoking patients experience
218 more symptoms earlier than non-smoking patients, leading to an earlier diagnosis and earlier
219 treatment. It is however difficult to evaluate if this has an effect on the treatment results since
220 we have no data on symptom duration. Also, the severity of the nerve compression depends
221 not only on the duration but also on the amount of elevated pressure on the nerve. One may
222 nevertheless speculate that smoking patients with CTS can improve their symptoms by
223 smoking cessation, regardless of surgery, and we would like to suggest that smoking patients
224 should be advised to stop smoking before OCTR, as this could possibly improve
225 postoperative results.

226

227 Our data also showed that 124 out of 493 patients (25%) did not experience a minimally
228 clinically important improvement; i.e. had a change less than 8 in QuickDASH total score
229 (Mintken et al., 2009). We have no apparent explanation for this observation. There was no
230 significant difference in how these patients rated their preoperative symptoms compared to
231 the rest of the patients. The variables that differed in the group of patients with a QuickDASH
232 change <8 were that they had slightly higher conduction velocities at wrist level and SNAP in
233 the middle finger preoperatively and that there was a higher proportion of patients with
234 polyneuropathy; thus, there was slightly less potential for improvement. Still, it is worrying
235 that such a large number of patients did not benefit from the surgery. It was recently reported

236 that symptoms in patients, who cancelled OCTR, improved over time, even though they did
237 not receive any surgical treatment (Pensy et al., 2011). In our opinion, this stresses the
238 importance of a correct diagnosis, and perhaps conservative treatment options should be used
239 to a higher extent before proceeding to surgical treatment, at least for patients with mild
240 symptoms. One may note that the QuickDASH does not assess if the patient is satisfied with
241 the surgery and that other conditions in the upper limb (other than symptoms originating from
242 the hand) may influence the results. We evaluated results one year after surgery, while
243 another recent study showed that a majority of patients operated on with OCTR was
244 completely or very satisfied, using Levine-Katz symptom and function scales, with the
245 surgery after ten years (Louie et al., 2013).

246

247 In the present study, electrophysiological findings supported the diagnosis in 67% of the
248 patients. The American Association of Orthopedic Surgeons (AAOS) recommends the use of
249 electrophysiological tests if clinical and/or provocative test are found positive, and surgical
250 treatment is considered (AAOS Guidelines, 2007). In our region, it is generally recommended
251 to perform electrophysiology testing before surgery only if the patient presents non-specific
252 clinical symptoms to ensure an accurate diagnosis. Previous studies have shown no
253 correlation between the findings on electrophysiology and the patient's symptoms (Itsubo et
254 al., 2009, Longstaff et al., 2001), and the present data support this notion (Figure 3).

255 Electrophysiology is a good method to grade the severity of compression, but it does not
256 measure the severity of carpal tunnel syndrome as experienced by the patient (Turner et al.,
257 2010). A slightly compressed nerve may induce severe symptoms, while at later stages (i.e.
258 more or longstanding compression) such symptoms may disappear.

259 Our interpretation of why such a large proportion of our patients had undergone an
260 electrophysiology testing before surgery is that many patients were referred directly to

261 surgery from the general practitioner in the primary health care system. A higher level of
262 knowledge regarding the clinical features of carpal tunnel syndrome in the primary health
263 care setting might help to reduce the number of unnecessary electrophysiology examinations.

264

265 Only 15/26 patients with normal electrophysiology values had a clinically significant
266 improvement (change >8 in QuickDASH score), indicating that some patients may even have
267 an incorrect diagnosis. Normal nerve conduction values have previously been associated with
268 worse surgical outcome (Bland, 2001), though it is known that patients with CTS can present
269 without pathological electrophysiology values (Finsen and Russwurm, 2001). It has also been
270 shown that electrophysiology alone could not predict patient recovery after surgery (Braun
271 and Jackson, 1994). Our results indicate that patients with extreme CTS are alleviated by
272 surgical intervention, but may have persistent symptoms indicating that they have already
273 suffered permanent nerve damage. Electrophysiology may be a complement to the clinical
274 examination in complicated cases, but it cannot alone guide the choice of treatment.

275

276 A limitation of this study is that 469 patients did not answer both QuickDASH questionnaires
277 or underwent a reoperation and were therefore not included in the study. We cannot with
278 certainty rule out the possibility that data from the non-responders may influence the results.
279 Unfortunately, we do not have any more data on the excluded patients. In addition, since the
280 QuickDASH formula is not disease specific, other arm/shoulder/hand-problems may affect
281 the score, but we had no detailed information about other symptoms in any patients.

282 Regarding smoking status, we unfortunately do not have information on how much the patient
283 smoked. We also cannot report any clinical outcome after surgery, since no postoperative
284 clinical controls were performed. We can only draw our conclusions from the self-reported
285 symptoms in the QuickDASH, and we do not have any objective data on the surgery outcome.

286 One might, however, argue that the most important factor in surgery outcome is the patient's
287 experience of symptom resolution.

288

289 The QuickDASH is a validated questionnaire and is routinely used at our clinic to evaluate
290 surgery outcome. However, it is not disease specific. In this study, we looked closer into some
291 items in the QuickDASH in an attempt to assess symptoms specific for carpal tunnel
292 syndrome. We also included some patients who were bilaterally operated during the study
293 period and since some of the items in QuickDASH are bimanual tasks, this might influence
294 the results.

295

296 In the logistic regression, we included electrophysiology data, which unfortunately meant that
297 many patients could not be included in the calculation, since many of our patients did not
298 undergo nerve conduction studies prior to surgery. This might influence the accuracy of the
299 statistics.

300

301 **Conclusions**

302 Our results demonstrate that smokers with CTS experience more pre- and postoperative
303 symptoms. Smokers with CTS improve by OCTR, but experience remaining disability.
304 Patients with normal or mild electrophysiology results have limited improvement after
305 surgery. Preoperative electrophysiology does not correlate with the patient's symptoms as
306 measured in QuickDASH. We emphasize that if the patient's symptoms and findings in
307 clinical examination is typical for CTS, it is not necessary to refer such a patient to a
308 preoperative electrophysiology test.

309

310

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318

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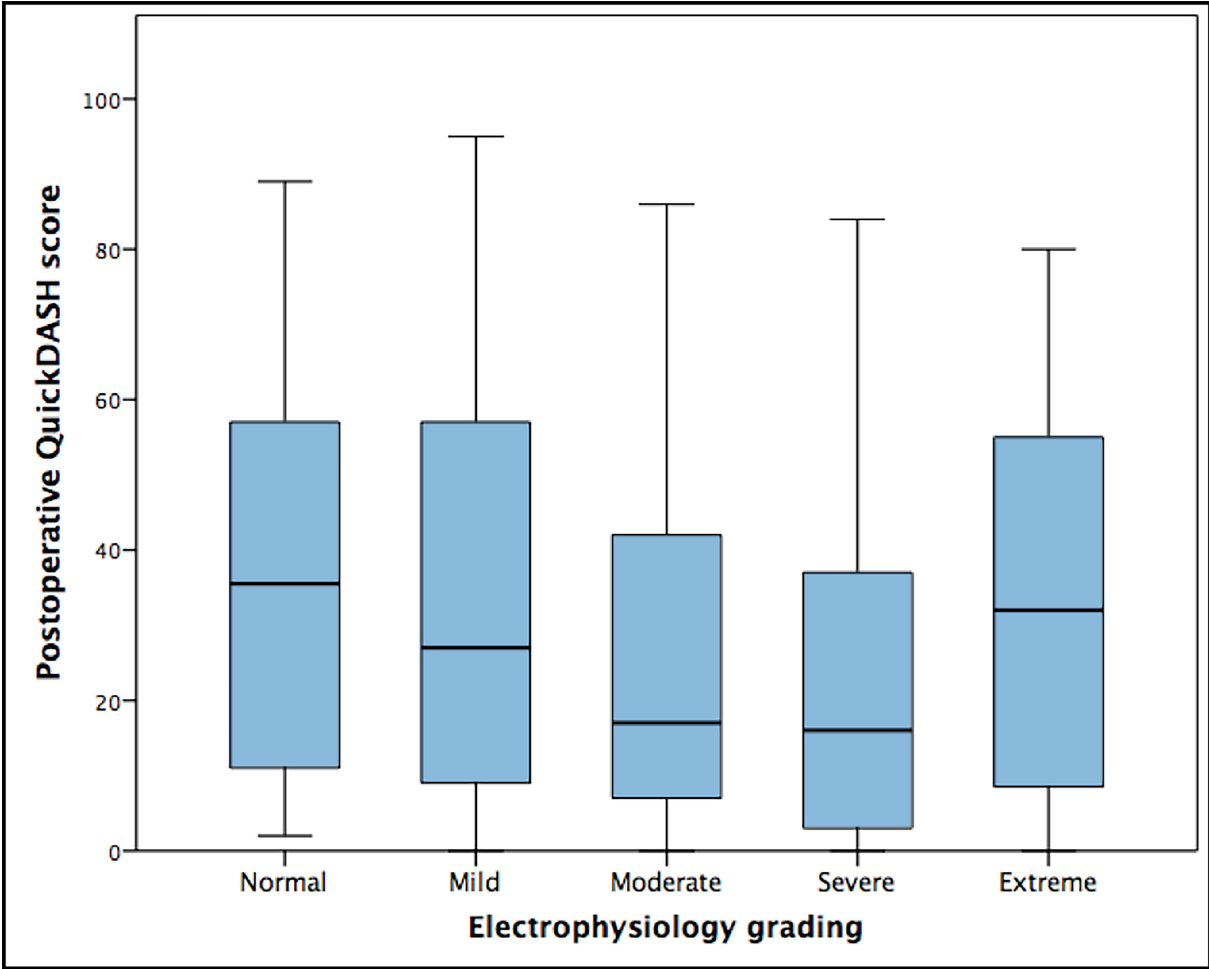
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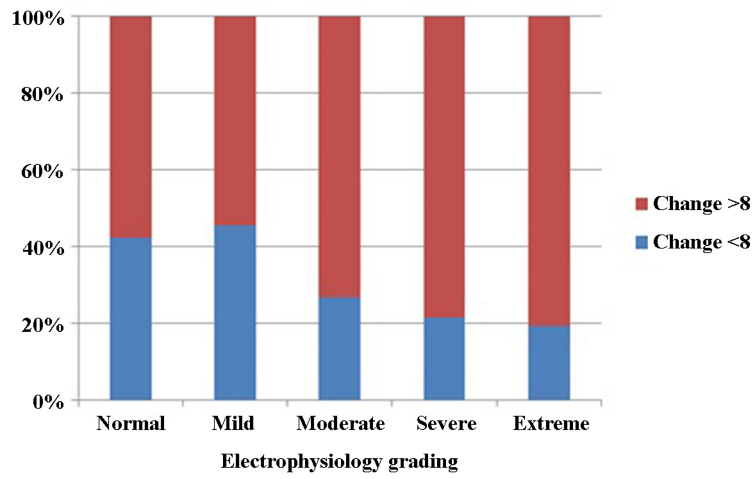
Figure legends

Figure 1. Postoperative outcome in relation to electrophysiology grading. Groups according to preoperative electrophysiology: normal (n=26), mild (n=30), moderate (n=123), severe (n=63) and extreme (n=43). Postoperative QuickDASH scores differed ($p=0.046$). The normal and extreme group showed higher QuickDASH scores than the severe group ($p=0.02$).

Figure 2: Proportion of patients with CTS and with a change in QuickDASH total score <8 (blue) in relation to electrophysiology grading. Normal (11/26, 42%), mild (13/30, 43%), moderate (35/123, 28%), severe (14/63, 22%) and extreme (8/43, 19%).

Figure 3. Linear regression showing no correlation (Spearman's r 0.003, $n=308$, $p>0.05$) between preoperative QuickDASH scores and sensory conduction velocity (SCV) in median nerve sensory branch at the wrist.





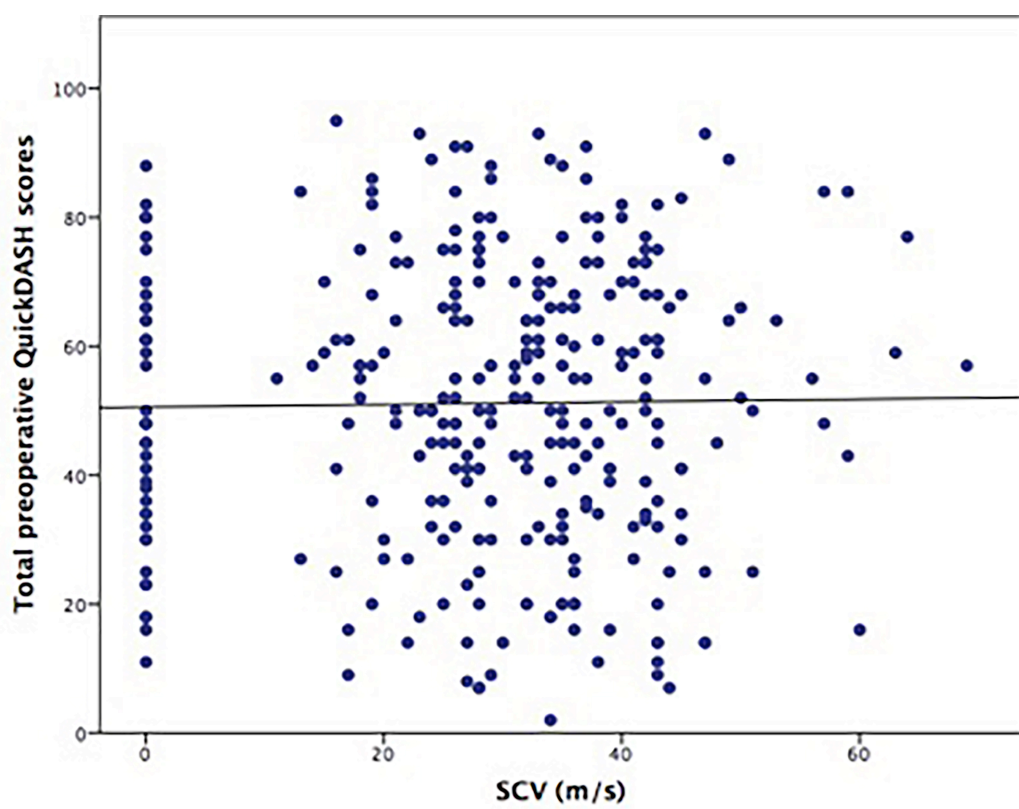


Table I. Clinical characteristics in 493 patients with carpal tunnel syndrome (CTS) treated with open carpal tunnel release.

	Smoking	Non-smoking	Change <8	Change >8	Total
	n=94	n=392	n=124	n=369	n=493
Gender (female)	72 (77)	268 (69)	84 (68)	259 (71)	343 (70) ^a
Age (years)	52 [45-60]	57 [48-69] *	56 [46-69]	55 [45-66]	55 [45-66] ^a
BMI	27 [24-32]	27 [25-31]	27 [24-30]	27 [25-31]	27 [24-31] ^a
Smoking			31 (25)	63 (17)	94 (19)
Diabetes Mellitus	15 (16)	61 (15)	24 (19)	52 (14)	76 (15) ^a
Hypertension	19 (20)	124 (32) *	38 (31)	105 (28)	143 (29) ^a
Exposure to vibrations	4 (4)	23 (7)	9 (8)	18 (5)	27 (6)
Polyneuropathy	7 (7)	18 (4)	12 (9)	14 (4) *	26 (5) ^a
Electrophysiology-verified diagnosis	61 (65)	234 (60)	83 (67)	216 (59)	299 (61)
Conduction velocity median nerve sensory branch over the wrist (m/s)	35 [26-39]	29 [21-38] *	34 [26-43]	29 [21-37] *	31 [23-38] ^a

SNAP middle finger (mV)	6.0 [3.0-11.0]	3.0 [0.0-8.0] *	5.0 [2.0-10.5]	3.0 [0.0-8.0] *	4.0 [1.0-8.0]
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Comparing the smoking patients vs. non-smokers as well as the patients that had a change in QuickDASH total score <8 vs. the patients that had a change in QuickDASH total score >8. All patients presented together in the last column for reference. In 7 cases data on smoking status was missing and could therefore not be included in the comparison. Nominal data presented as number (%). Continuous data presented as median [IQR]. *p<0.05

^aData already published (Zimmerman et al., 2016)

Zimmerman M, Dahlin E, Thomsen NO, Andersson GS, Bjorkman A, Dahlin LB. Outcome after carpal tunnel release: impact of factors related to metabolic syndrome. Journal of plastic surgery and hand surgery. 2016: 1-7.

Table II. QuickDASH scores in 493 patients with carpal tunnel syndrome (CTS) operated with open carpal tunnel release.

	Smoking n=94	Non-smoking n=392	Change <8 n=124	Change >8 n=369	Total n=493
Total preoperative QuickDASH score	61 [45-74]	48 [30-64] **	48 [26-64]	50 [34-68]	50 [32-66] ^a
Total postoperative QuickDASH score	34 [14-61]	16 [5-41] **	56 [30-73]	11 [3-31] **	18 [5-45] ^a
Change in total QuickDASH score	20 [5-36]	21 [9-36]	-2 [-11-4]	30 [18-41] **	21 [8-36] ^a
Change in total QuickDASH score <8	31 (33)	92 (23)			124 (25) ^a
Total postoperative QuickDASH score >10	73 (77)	232 (59) *	110 (90)	198 (53) **	308 (63) ^a
Change in total QuickDASH score >10	21 (23)	146 (38) *			171 (35)

score >8 and total

postoperative QuickDASH

score <10

Comparing the smoking patients vs. non-smokers as well as the patients that had a change in QuickDASH total score <8 vs. the patients that had a change in QuickDASH total score >8. All patients presented together in the last column for reference. In 7 cases data on smoking status was missing and could therefore not be included in the comparison. Nominal data presented as number (%). Continuous data presented as median [IQR]. *p<0.05, **p<0.0001

^aData already published (Zimmerman et al., 2016)

Zimmerman M, Dahlin E, Thomsen NO, Andersson GS, Bjorkman A, Dahlin LB. Outcome after carpal tunnel release: impact of factors related to metabolic syndrome. *Journal of plastic surgery and hand surgery*. 2016: 1-7.

Table III. Logistic regression of hands with carpal tunnel syndrome (CTS) treated with open carpal tunnel release.

	Change in QuickDASH total score <8 OR	Postoperative QuickDASH score >10 OR
Smoking	1.61 (0.98-2.62)	2.40 (1.42-4.06)**
<i>Model 1</i>	1.63 (0.99-2.75)	2.31 (1.33-4.03)*
<i>Model 2 §</i>	1.82 (0.93-3.57)*	2.47 (1.11-5.50)
SNAP middle finger §	1.05 (1.00-1.10)*	1.03 (0.99-1.08)
<i>Model 1</i>	1.06 (1.00-1.11)*	1.04 (0.99-1.10)
<i>Model 2</i>	1.01 (0.94-1.08)	1.02 (0.95-1.10)
SCV median nerve at wrist level §	1.02 (1.00-1.04)	1.01 (0.99-1.03)
<i>Model 1</i>	1.02 (1.00-1.05)	1.01 (0.99-1.04)
<i>Model 2</i>	1.02 (0.99-1.05)	1.00 (0.98-1.04)

Model 1 = adjusted for BMI, hypertension, diabetes, exposure to vibrations, polyneuropathy, age and sex

Model 2 = model 1 with SNAP middle finger, SCV median nerve at wrist level and smoking added

Dependent variables: change <8 in QuickDASH total score, postoperative QuickDASH score >10.

§283 patients included in the analysis

*p<0.05 **p<0.001